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DESCRIPTION OF A NEW SPECIES, *FUNDULUS JULISIA*, WITH A REDESCRIPTION OF *FUNDULUS ALBOLINEATUS* AND A DIAGNOSIS OF THE SUBGENUS *XENISMA* (TELEOSTEI: CYPRINODONTIDAE).

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Introduction

This paper describes a new species of *Fundulus* from the Barrens Plateau area of middle Tennessee. It also provides additional descriptive data for the poorly known and presumably extinct whiteline topminnow, *Fundulus albolineatus* Gilbert, from Big Spring, Huntsville, Madison County, Alabama. The Barrens topminnow, described herein as *Fundulus julisia*, was first collected during preimpoundment surveys conducted by the Tennessee Valley Authority (TVA) in the late 1930s. Most of the specimens were small, but one tuberculate male, 42 mm SL, was taken on April 1, 1937. The three collections of Barrens topminnows taken in 1937 were recognized as a distinct species by C. L. Hubbs in 1938. These collections were deposited in the University of Michigan Museum of Zoology where they were subsequently catalogued as *Fundulus albolineatus*. After the original collections in the spring of 1937, it was not taken again until the mid 1960s. In recent years, the new species and *F. albolineatus* had been considered conspecific until recent work by J. S. Ramsey, R. W. Bouchard, and ourselves indicated it is more likely that they represented two species. These species share many meristic, morphological, and pigment characters with three other upland species; *Fundulus catenatus* (Storer), the northern studfish; *F.*

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stellifer (Jordan), the southern studfish; and *F. rathbuni* (Jordan and Meek), the speckled killifish. The combined group appears to represent a distinct phyletic line in the genus *Fundulus*. Various authors (Brown, 1957; Farris, 1968; Chen, 1971) have placed some or all of the above species in a species group, for which the subgeneric name *Xenisma* Jordan has been used. Brown (1957) included *F. catenatus*, *F. stellifer*, *F. rathbuni*, and *F. albolineatus* in *Xenisma* (his concept of *F. albolineatus* was based on specimens of the species from middle Tennessee, described herein as new), but Farris (1968) and Chen (1971) suggested that the subgenus *Xenisma* also includes additional species of *Fundulus* such as *F. diaphanus*, *F. waccamensis*, *F. seminolis*, and *F. parvipinnis*. Farris' (1968) analysis was based primarily on skull morphology. Chen (1971) compared karyotypes of 20 species of *Fundulus*, but unfortunately the only member of *Xenisma* (*sensu*, Brown, 1957) examined was *F. rathbuni*, which showed closest karyological affinities with the species pair *F. diaphanus* and *F. waccamensis*. Miller (1955) did not utilize subgeneric names within *Fundulus* but implied a relationship among the *Xenisma* species by listing *F. catenatus*, *F. stellifer*, *F. rathbuni*, and *F. albolineatus* together in his "tentative phylogenetic sequence." We contend that *Xenisma* (*sensu*, Brown, 1957), exhibits and/or shares sufficient character states either not exhibited or not shared by other *Fundulus* to be recognized as a valid and monophyletic subgenus.

The diagnosis of the subgenus *Xenisma* presented herein should facilitate future efforts to determine subgeneric limits in the genus *Fundulus*. In examining the genus *Fundulus*, Miller (1955) recognized 26 recent species and pointed out that additional study was needed before subgeneric divisions could be made. Brown (1957) provided a key to 33 species and subspecies of the genus *Fundulus* which he placed in five subgenera, none of which were diagnosed. Subsequent workers have generally followed the subgeneric limits of Brown (1957) but there have been no attempts to diagnose any subgenus of the genus *Fundulus*. Hubbs and Burnside (1972), on the basis of developmental and karyological data, concluded that *F. notatus* and *F. olivaceus* were sufficiently distinct from other *Fundulus* to warrant generic separation. The oldest available name for these species is *Zygonectes*. A third species, *Fundulus euryzonatus*, recently described by Suttkus and Cashner (1981) was referred to the subgenus *Zygonectes*. Most recently Parenti (1981) diagnosed the genus *Fundulus* and noted that the decision to recognize subgenera was "a problem for a future revisor."

Three species of the subgenus *Xenisma* have been the subject of detailed studies. Brown (1955) reported on variation and relationships of *F. rathbuni*, and Thomerson (1969) published on the systematics of *F. catenatus* and *F. stellifer*. *Fundulus albolineatus*

was described by Gilbert (1891) and is known only from 25 specimens taken from Big Spring Branch at Huntsville, Alabama.

Methods and Materials

Fin ray counts were made following methods described by Hubbs and Lagler (1958). The method of counting dorsal and anal fin rays used by Brown (1957) and Thomerson (1969) result in one more fin ray per fin than the standard method. These fin ray counts are adjusted herein to make them similar to the counts obtained using the methods of Hubbs and Lagler (1958). Scale counts were made according to the methods described by Hubbs and Lagler (1958) except as noted below. Transverse or vertical scale rows were counted on the left side only, in a zig-zag fashion from and including the scale on the dorsal midline at the anterior origin of the dorsal fin ventrally to the last scale before the ventral midline (Thomerson, 1969). Measurements were made following methods of Thomerson (1969). The terminology used for describing sensory canal system of the head follows that of Gosline (1949). Head squamation pattern follows the description presented by Hoedeman (1958). The genus *Fundulus* is implied for all species epithets that appear without a generic name or initial. Specimens examined have been kindly provided by the following museums: University of Alabama Ichthyological Collection (UAIC), Auburn University (AU), California Academy of Sciences (CAS) and the Stanford University (SU) collection stored at the California Academy of Sciences, Cornell University (CU), University of Michigan Museum of Zoology (UMMZ), University of North Carolina at Charlotte (UNCC), Tulane University (TU), University of Tennessee (UT), and United States National Museum (USNM). We thank the curators in charge of these collections for making this material available.

Information on the karyotype of *Fundulus julisia* was graciously provided for inclusion in this paper by W. M. Howell and Ann Black, Samford University, Birmingham, Alabama. The data were taken from one adult male and three adult females collected at the type locality on 14 June 1979.

Chromosome Methodology.—The fishes were injected intraperitoneally with 0.5 ml of 0.1 percent colchicine and were returned to the minnow bucket. After 8-12 hours, they were sacrified by decapitation. Tissues from gills, scales and testes were removed and fixed in two changes of 3:1 methanol glacial acetic acid for 15 minutes each. Prepared tissue was dabbed on to the surface of a microscope slide. This action released a slurry of cells which was air-dried and stained in 4 percent Giemsa stain.

Subgenus Xenisma Jordan

Xenisma Jordan, in Jordan and Copeland 1877:142. Type species, *Xenisma stellifera* Jordan, by original designation.

Included species.—*Fundulus catenatus*, *F. stellifer*, *F. rathbuni*, *F. albolineatus*, and *F. julisia* (described herein).

Diagnosis.—In all species of the subgenus *Xenisma*, all stages of both sexes lack a broad, darkly pigmented lateral band, a large, darkly pigmented subocular "teardrop" blotch, and vertical bars on sides of body. Nuptial males have well developed red, blue, and yellow breeding colors (nuptial colors unknown for *albolineatus*). Nuptial males with terminal and/or subterminal dark and/or chromatic band on caudal fin. Nuptial males with tubercles consistently absent from nape and top of head, but present on dorsal and anal fins, cheeks and opercles (*albolineatus* lacks tubercles on the cheeks and opercles) and in some species developing on paired fins (*catenatus*, *rathbuni*, *stellifer*) and breast scales (*rathbuni*). Midlateral body scales of nuptial males with 3-5 tubercles per scale. Dorsal fin origin posterior to anal fin origin. Vertebrae 33-38. Caudal rays 14-19. Branchiostegal rays 6-6, rarely 5 in *rathbuni*. Total gill rakers 4-7, very blunt, most slender and elongate ones with their basal width as great as their length. Lacking a conspicuous ridge of connective tissue on the dorsal portion of the pharynx, extending anteriad from the level of the uppermost gill raker.

Additional Characters.—Dorsal fin rays 9-15. Anal fin rays 10-17. Pectoral fin rays 14-19. Lateral line scales 34-52. Transverse scale rows 11-18. Caudal peduncle scales 16-24. Gill openings vary from restricted in *julisia* to only moderately restricted in the other species. Head scales consistently in the "A pattern" of Hoedeman (1958). Preopercular canal pores typically 7 in *rathbuni*, *albolineatus*, and *julisia* and 8 in *catenatus* and *stellifer*. Mandibular canal typically with 4 pores, with anterior pores (Z and Z') more widely spaced than pores Z and Y (these distances about equal in *rathbuni* and occasional specimens of *catenatus* and *stellifer*). Preoperacular and mandibular canals widely separated. Supraorbital canals with pore 2b behind or rarely (*catenatus*) even with middle of posterior nostril, pores 2a and 2b more widely spaced than pores 3 and 4a. Postorbital canal extremely variable, but typically with pore 6 completely or partly divided; and with the canal between pores 4b and 5 persistent. Gosline (1949) indicated that this canal was typically absent in *stellifer*, but it was consistently present in the 20 specimens we examined. Pit organs near tip of snout not connected by canal.

Discussion.—In the subgenus *Xenisma*, the absence of a broad, darkly pigmented lateral band, a darkly pigmented subocular "teardrop" blotch, and vertical bars on the sides distinguish it from all species of *Fundulus* with one exception, *sciadicus*. Three species of

Fundulus, euryzonatus, notatus, and *olivaceus* have a broad, darkly pigmented lateral band and are usually assigned to the subgenus *Zygonectes* (see Suttkus and Cashner, 1981; Hubbs and Burnside, 1972). The *nottii* species group is characterized by having a darkly pigmented subocular "teardrop" blotch and numerous stripes between the flank scales of females (Wiley, 1977). All other species of the genus *Fundulus*, with the exception of *sciadicus*, have vertical bars on the sides of one or both sexes. *Fundulus sciadicus* can be distinguished from species of the subgenus *Xenisma* in having one or two breeding tubercles per scale on mid-lateral body scales (3-5 tubercles per scale in *Xenisma*); 31-34 vertebrae (33-38 in *Xenisma*); 19-22 caudal rays (14-19 in *Xenisma*) and 5-5 branchiostegal rays (6-6 in *Xenisma*, rarely 5 in *rathbuni*).

Distribution.—Species of the subgenus *Xenisma* are virtually restricted to fresh waters above the Fall Line in southeastern and southcentral United States. The exceptions are *stellifer* with populations on the coastal plain in the Alabama River drainage and *catenatus* with populations in tributaries to the Mississippi River in southwest Mississippi.

Fundulus albolineatus Gilbert
Whiteline Topminnow
Fig. 1

Fundulus albolineatus Gilbert, 1891:149 (original description).

Types.—Lectotype: We select USNM 125055 (male, 70 mm SL), collected by P. H. Kirsch, U.S. Bureau of Fisheries, in Spring Creek, Huntsville, Madison County, Alabama, 27-28 May 1889 from the syntypic series as the lectotype. The remaining syntypes (USNM 225996(1), UMMZ 157629(1), CAS 44176(9) and SU 1029(8)) became paralectotypes.

Additional material.—The only other known collection of *F. albolineatus* (USNM 63133) was originally catalogued as *F. catenatus*. These five specimens were also collected by P. H. Kirsch from Huntsville, Madison County, Alabama, 27-28 May 1889.

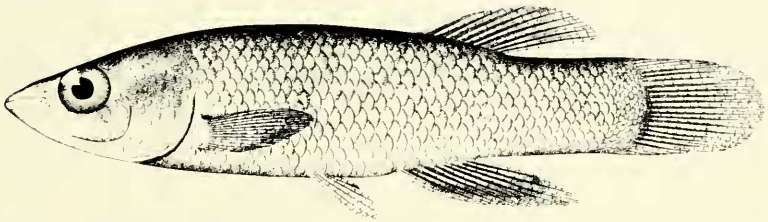

FIG. 1.—*Fundulus albolineatus*. Gilbert, 1891. Lectotype (USNM 125055), male 70 mm SL, collected in Spring Creek, Huntsville, Madison County, Alabama, May 27-28, 1889. This figure is reprinted from the original plate XLIII, Fig. 1, published by Gilbert, 1891. Drawing by S. F. Denton.

Diagnosis.—A member of the subgenus *Xenisma* as diagnosed in this paper. Most similar to *F. julisia* from which it differs in "having the rows of scales with interrupted whitish streaks, most conspicuous on hinder half of body" in adult males (Gilbert, 1891). Whitish streaks are still discernable even though specimens are badly faded. Additional color and pigmentation differences between *albolineatus* and *julisia* can be inferred, but are relegated to the description due to the unclear and sketchy nature of Gilbert's (1891) comments and our difficulty in interpreting pigment patterns in these extremely faded specimens. *Fundulus albolineatus* lacks breeding tubercles on the cheeks and opercles (present in other species of *Xenisma*). Meristically most similar to *rathbuni* and *julisia*, but differing from both (Table 1) in having more lateral-line scales (usually 40 vs. usually 39 or fewer), and fewer vertebrae (usually 34 vs. 35 or more). Further differs from *rathbuni* in lacking a darkly pigmented line extending from under eye obliquely forward to angle of the jaw (Fig. 2), and in having the supraorbital canal system of head very abbreviated, with pores 2b, 3, and 4a having their diameters approximately equal to the intervening segments of the canal. Differs from both *catenatus* and *stellifer* in having 7 rather than 8 preopercular canal pores, fewer dorsal rays (9-11, usually 10 vs. 11-15, usually 12-14), fewer anal fin rays (10-12, usually 11 vs. 12-17, usually 13-15), fewer vertebrae (33-35, usually 34 vs. 35-38, usually 36-37), and fewer lateral-line scales (37-43, usually 40 vs. 38-52, usually 41-48) (Table 1).

Description.—Males reaching lengths of 78 mm SL, females reaching 75 mm SL. Due to the condition of the 25 extant specimens it was not possible to obtain precise body proportions. The general body shape is illustrated in Fig. 1. This is the drawing by S. F. Denton used by Gilbert (1891) in the original description of *F. albolineatus*. The specimen illustrated appears to be the large (70 mm SL) male we selected as the lectotype. Measurements and body proportions reported by Gilbert (1891) are as follows: head 3⅓ to 3⅗ into length; depth 4 to 4½ into length; least depth of caudal peduncle equals snout plus ⅔ eye; interorbital distance 2¼ to 2⅓ into head length; snout ⅓ length of head; dorsal and anal fin bases equal in length and short, equaling length of snout plus half of eye; in males both dorsal and anal fins become elevated, the longest anal ray equaling ⅔ of head length; depressed pectoral fin reaches pelvic insertion; depressed pelvic fin reaches to or nearly to the anus; pectoral and pelvic fins shorter in females. Gilbert (1891) reported that dorsal and anal fin origins were at the same level or the dorsal origin was slightly anterior to anal origin. This appears to be in error since the illustration of the species and our observations indicate the dorsal fin origin to be slightly posterior to the anal origin. Examination of radiographs shows the first interneural spine extending anteriad and not interdigitating with neural

TABLE 1.—Number of fin rays, vertebrae and scales in the five species of *Fundulus* in the subgenus *Xenisma*. * = data from Thomerson (1969) and + = data from Brown (1957).

	Dorsal Rays							
	9	10	11	12	13	14	15	N
*F. catenatus**				34	132	113	14	293
*F. stellifer**			2	121	220	38	5	386
F. rathbuni +		71	83	20	1			175
F. julisia	3	49	24	3				79
F. albolineatus	2	11	4					17

	Anal Rays								
	10	11	12	13	14	15	16	17	N
*F. catenatus**				4	100	149	44	3	300
*F. stellifer**			8	172	186	18	1		385
F. rathbuni +	6	90	80						176
F. julisia	4	58	18						80
F. albolineatus	6	11	1						18

	Pectoral Rays						
	14	15	16	17	18	19	N
*F. catenatus**	2	16	119	135	12	1	285
*F. stellifer**		15	167	180	24	1	387
F. rathbuni	1	3	43	52	10		109
F. julisia	11	43	15	1			70
F. albolineatus		13	8	1			22

TABLE 1.—*Continued*

	Caudal Rays (Branched +2)									
	13	14	15	16	17	18	19			N
*F. catenatus**			4	50	58	3				115
*F. stellifer**		2	28	126	69					225
F. rathbuni	1	23	44	27	3					98
F. julisia			2	35	22	9	2			70
F. albolineatus				3	3	3				9
	Vertebrae									
	33	34	35	36	37	38				N
F. catenatus				25	61	12				98
F. stellifer			2	23	28	2				55
F. rathbuni		5	9	1						15
F. julisia		1	12	5						18
F. albolineatus	1	18	6							25
	Caudal Peduncle Scales									
	16	17	18	19	20	21	22	23	24	N
F. catenatus		5	6	51	9	1				72
F. stellifer					3	19	19	8	2	51
F. rathbuni +	2	4	7	33	115	1				162
F. julisia		2	4	25	33	1	1			66
F. albolineatus			1	3	10	8	2			24

TABLE 1.—*Concluded*

	Lateral-Line Scales																			
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	N
*F. catenatus**						2	2	11	15	26	33	34	49	38	34	16	13	5	4	282
*F. stellifer**					4	9	13	33	34	51	50	48	43	39	26	11	13	4	1	379
F. rathbuni	12	29	32	20	9	4	1													107
F. julisia		1	4	9	24	15	6	6	2	1										66
F. albolineatus				1	1	5	10	5	2	1										25

	Transverse Scale Rows								
	11	12	13	14	15	16	17	18	N
*F. catenatus**	2	18	85	128	43	6			282
*F. stellifer**			5	62	166	94	39	1	367
F. rathbuni		1	11	51	9				72
F. julisia			1	13	27	4	1		46
F. albolineatus				7	12	1			20

spines; the interneural spine of the second dorsal fin ray lies between the neural spines of the 16th and 17th vertebrae. The interhemal spines associated with the first two anal rays are between the hemal spines of the 15th and 16th vertebrae. Sensory canal system of head basically as described for subgenus *Xenisma.*

Gilbert (1891) apparently saw the original types only after they had been in preservative for some time, since he reported no chromatic colors which surely would have been present on these nuptial specimens. He reported the color of males as "blackish brown, the sides plumbeous, the rows of scales with interrupted whitish streaks, most conspicuous on hinder half of body. A black streak along middle line of back. Vertical fins dusky, the caudal becoming translucent on distal half, its margin abruptly and narrowly black-edged." The translucent band adjacent to the black margin of the caudal fin was probably brightly colored, yellow to orange in life, as is characteristic of other species of the subgenus *Xenisma.* Females were described by Gilbert (1891) as being "olivaceous, dusky on back, silvery below, the back and side with narrow black lines following the rows of scales. Fins translucent, the dorsal sometimes with fine specks at base, the caudal black edged." Very little of the pigment pattern remains on the 25 extant specimens which have faded to an almost uniform brown color. The discernable pigment pattern on the body is as follows: males with a prominent white predorsal streak partially overlain with melanophores, and with 6-7 broken white lines laterally on the posterior half of body, each line follows the central ¼ to ⅓ of the exposed field of the scale; females with dark spots forming thin lines along the center of the exposed field of scales on 3-5 rows of scales on each side of the dorsal midline; larger spots present on sides of females but do not appear to form rows. The dorsal, anal, and pectoral fins of males appears dusky with pigment present on rays and membranes; on the dorsal and anal fins the concentration of dusky pigment appears to be heavier on the posterior 2-3 rays than on the anterior rays. The caudal fin in males has a narrow marginal dark band, a light submarginal band, and the basal ⅔ of the fin is dusky. Females with a narrow dark marginal band on caudal fin that is less prominent than that of males. Nuptial tubercles, present only on males, occur on the dorsal and anal fins and mid-lateral body scales. Some males have a few tubercles on the anterior caudal peduncle scales. On the dorsal fin, they are present on the first eight rays. Tubercles are present on the distal ½ to ⅔ of the anal fin, with the largest tubercles on the branched rays. There are about 3-5 tubercles on the periphery of the mid-lateral body scales. The 15 nuptial males examined lack tubercles on the paired fins, cheeks, and opercles.

Habitat.—The only known habitat of the whiteline topminnow was Big Spring and its outflow, Spring Creek, in Huntsville, Madi-

son County, Alabama. The habitat was described by Gilbert (1891) as follows: "Spring Creek, Huntsville, May 27 [1889]. Temperature 65° F. This small stream about 18 feet wide is formed by a single spring in the town of Huntsville. It is about ¼ of a mile long and flows into Pin-hook Creek. Its bottom is similar to that of the former [Pin-hook Creek, Huntsville, bottom of blue limestone]. It is full of fishes, darters being very numerous." Armstrong and Williams (1971) reported on two collections from Big Spring in Huntsville but no *F. albolineatus* were taken. Big Spring has been drastically altered since the turn of the century. According to local residents, the spring has been pumped dry on several occasions. The banks of the spring and the spring run have been lined with cement. The spring outflow flows through a city park and has been impounded and stocked with carp and goldfish. Native fishes reported from Big Spring by Armstrong and Williams (1971) include *Semotilus atromaculatus*, *Rhinichthys atratulus*, *Campostoma anomalum*, *Catostomus commersoni*, and *Etheostoma squamiceps*.

Status.—Spring type habitats near the lower bend of the Tennessee River and in the adjacent upper portion of the Mobile Basin drainage contain at least five additional endemic species. In the upper Mobile Basin springs, *Cottus pygmaeus* is known only from Coldwater Spring, Calhoun County, Alabama (Williams, 1968); *Etheostoma nuchale* occurs in several springs near Birmingham, Jefferson County, Alabama (Howell and Black, 1976); *Etheostoma ditrema* is somewhat more widespread and occurs in at least seven localities in Alabama, Georgia, and Tennessee (Ramsey, 1976; Stiles and Etnier, 1971, and an unpublished record, UT 91.782). In the lower bend of the Tennessee River *Elassoma* sp., formerly known from Cave Spring, Lauderdale County, Alabama, and Pryor Springs, Limestone County, Alabama has been extirpated from these areas but was recently rediscovered in Moss Spring, Limestone County, Alabama; *Etheostoma tuscumbia* persists in about 10 springs in northern Alabama (Ramsey, 1976). Rediscovery of *Elassoma* sp. and a thriving *E. tuscumbia* population in Moss Spring, Limestone County, Alabama, in 1973 raised hopes that *F. albolineatus* might occur there. After considerable collecting effort in Moss Spring, this no longer seems likely. Although discovery of an extant population of *F. albolineatus* in springs near the lower bend of the Tennessee River remains a possibility, it seems more likely that the species is extinct.

Fundulus julisia, sp. nov.

Barrens Topminnow

Fig. 2

Fundulus albolineatus Gilbert.—Miller, 1955:9 (distribution in Ten-

nessee).—Brown, 1957:71 and 74 (distribution in Tennessee).—Farris, 1968:4 (used in osteological comparisons).—Armstrong and Williams, 1971:110 (reported from Coffey County, Tennessee).—Ramsey, 1976:63 (reported related form from eastern Highland Rim of central Tennessee).

Fundulus sp.—Miller, 1972:214 (reference to Barrens topminnow in Tennessee).—Bouchard, 1973:40 (reference to undescribed *Fundulus*).—Srivastava and Griffith, 1974:137-139 (reported from springs in Tennessee).—Griffith, 1974:320, 321, 324, 326 (unnamed form from Tennessee, Barrens topminnow).—Deacon et al., 1979:41 (Barrens topminnow, color photograph).

Holotype.—Adult male, USNM 225997, 53.8 mm SL, spring tributary to West Fork Hickory Creek, Caney Fork River system, Cumberland River drainage, at Tennessee Highway 55, 0.3 rd. mile northeast of junction with County Road 4292, Summitville, Coffee County, Tennessee (spring originates from cave on Joseph R. Banks property, on north side of Tennessee Highway 55), 1 April 1973, collected by David Etnier, Ray Bouchard, and Frank V. Oakberg.

Paratopotypes.—UT 60.103(1), same date as for holotype; UAIC 2417(1), 18 December 1966; UAIC 2536(7), 13 April 1967; UT 60.28(13), 20 October 1968; AU 15728 (11), 13 September 1969; UT 60.53(1), and UT 60.55(5), 3 May 1972; UT 60.61(2), 30 September 1972; UT 60.218(5), 9 July 1977; University of Tennessee Zooarchaeology Collection 4405(1), disarticulated skeleton, 5 May 1978; USNM 225999(1), 11 March 1979; Florida State Museum (UF) 31452(2), Illinois Natural History Survey (INHS) 87282(2), Academy of Natural Sciences of Philadelphia (ANSP) 146524(2), University of Kansas (KU) 18845(2), UMMZ 207690 (2), USNM 225998(2), all from 14 June 1979, and originally property of Samford University, Birmingham, Alabama; UT 60.225(2), 23 May 1981.

Additional Paratypes.—Caney Fork River system, Cumberland River drainage, Coffee County, Tennessee: TU 33495(1), tributary to Hickory Creek, 13.1 mi southwest of McMinnville, on Tennessee Highway 55, 17 July 1964; AU 11059(5), West Fork Hickory Creek 0.8 mi. south of Summitville, 0.2 mi. south of Tennessee Highway 55, on County Road 4292, 28 August 1975; AU 12715(1), same locality as AU 11059, 18 March 1976. Duck River system, Tennessee River drainage, Coffee County, Tennessee: UMMZ 120861(3),

FIG. 2.—Breeding males of four species of the subgenus *Xenisma*. The four species from top to bottom are *Fundulus catenatus* (♂ 115 mm SL collected 12 May 1973, Mulherrin Creek, Smith County, Tennessee), *F. stellifer* (♂ 97 mm SL collected 29 April 1973, Conasauga River, Bradley County, Tennessee), *F. rathbuni* (♂ 75 mm SL collected 28 April 1979, Back Creek, Mecklenburg County, North Carolina), and *F. julisia* (♂ 68 mm SL collected 23 May 1981, spring tributary to West Fork Hickory Creek, Coffee County, Tennessee).

spring branch above Ovaca Lake, north of Tullahoma, 26 March 1937; UMMZ 120914(8), Little Duck River at Tennessee Highway 55, northeast of Manchester, 30 March 1937; UMMZ 121014(7), Doak Springs on Hunt Creek, southeast of Manchester, 1 April 1937; TU 33511(3), same locality as UMMZ 120914, 17 July 1964.

Diagnosis.—A member of the subgenus *Xenisma* as diagnosed herein. Most similar to *albolineatus*, but differs most notably in the absence of interrupted whitish streaks on posterior half of the body in breeding males. The body of breeding males of *julisia* is iridescent yellowish green with scattered orange to reddish orange spots. It also differs from *albolineatus* in having a lower modal lateral-line scale count (38 or 39 vs. 40), and a higher modal vertebral count (35 vs. 34). Differs from *catenatus* and *stellifer* in having fewer dorsal fin rays (9-12 vs. 11-15), fewer anal fin rays (10-12 vs. 12-17), fewer vertebrae (34-36 vs. 35-38), and fewer lateral-line scales (36-42 vs. 38-52) (Table 1). Differs from *rathbuni*, *catenatus*, and *stellifer* in lacking nuptial tubercles on paired fins, and caudal peduncle scales; differs from *albolineatus* in having tubercles on the cheeks and opercles; and in having an extremely abbreviated supraorbital canal, in which pore diameters of pores 2b, 3, and 4a are essentially equal to lengths of canal segments between these pores (segments of this canal are much longer than pore diameters in those three *Xenisma*). Further differs from *rathbuni* in lacking tubercles on breast scales and in lacking a darkly pigmented line extending from under eye obliquely forward to angle of jaw (Fig. 1).

Description.—Measurements expressed as thousands of SL, for 10 adult males and 10 adult females (mean and range for males, followed by datum for holotype, followed by mean and range for females) are as follows: SL 47.4, 35.5-58.8, 53.8, 50.5, 42.8-78.2; head length 287.1, 276-299, 285, 274.8, 263-285; head depth 170.3, 155-189, 162, 159.4, 148-177; head width 170.7, 160-180, 169, 162.4, 147-179; snout length 97.1, 85-107, 99, 87.1, 78-102; orbital diameter 81.7, 74-89, 74, 75.2, 68-82; predorsal length 660.0, 645-675, 668, 677.6, 653-694; caudal peduncle length 234.5, 223-250, 240, 232.5, 206-246; caudal peduncle depth 130.0, 124-133, 132, 123.5, 117-133; body depth 218.3, 202-227, 222, 221.0, 199-236; length of anal fin base 138.9, 130-154, 136, 124.6, 106-139; anal fin length 294.6, 282-306, 294, 222.5, 202-236; caudal fin length 256.5, 236-280, 246, 234.5, 211-247; dorsal fin length 272.6, 248-308, 275, 215.2, 203-234; pectoral fin length 177.4, 167-190, 179, 168.1, 156-186; pelvic fin length 123.0, 107-132, 132, 99.4, 91-107.

Nuptial males with blackground color of pale blue-green to yellow-green on sides of head and body, fading to white on ventral surface; diffuse orange to dark red spots, each approximately occupying the exposed field of a scale, liberally scattered on sides, and on head below cheek, on operculum, and occasionally present on ventral surface of head and body; dorsum olivaceous, with a promi-

nent iridescent, white to pale gold mid-dorsal stripe extending from dorsal-fin origin about ¾ distance to occiput; anal fin orange-yellow, with scattered orange spots; paired fins yellow, occasionally with a few orange spots near base; both caudal and dorsal fins with a few orange spots near base; caudal fin and occasionally posterior portion of dorsal fin with a broad pale yellow submarginal band and narrow dark margin. All fins with many small dark chromatophores along rays and on membranes; eye with iris bright yellow darkened by scattered dark chromatophores. Freshly captured females and juveniles much more subdued, brownish gray on sides with widely scattered dark brown spots about size of orange spots of male (not with "narrow black lines following the rows of scales" as reported for *albolineatus* by Gilbert); dorsal and caudal fins with small dark chromatophores margining rays and abundant on membranes; dark chromatophores absent from paired fin membranes and few on anal fin; dark predorsal streak extends from dorsal-fin origin to occiput. Pigmentation of females and juveniles changes little in preservative. Males in preservative lose orange and red spots, leaving sides uniformly pigmented (not with "the rows of scales with interrupted streaks" as reported for *albolineatus* by Gilbert); pale yellow band on caudal fin detectable only as a pale area near fin margin (black marginal band on the caudal fin noticed by Gilbert on *albolineatus* is often not evident in preserved specimens of *julisia*); iridescent predorsal streak becomes dark brown.

Somatic chromosome counts from both gill and scale tissues were $2n = 48$ in both male and female (Table 2). No chromosomal sexual dimorphism is apparent. The chromosomes are all acrocentric except for a single pair of small submetacentrics (Fig. 3). Meiotic chromosome counts from testes of the male were $n = 24$. Although this karyotype is similar to that reported for *F. rathbuni* (Chen, 1970), it differs very little from that of several other species of *Fundulus* reported in that paper. It is also similar to the karyotype of *F. stellifer* reported by Denton & Howell (1969). Our lack of expertise in this area forces us to relegate the critical comparison of *Fundulus* karyotypes to serious students of this technique.

Habitat.—The Barrens topminnow is known from springs, spring runs, and small streams strongly influenced by groundwater. In both the type locality and Little Duck River, watercress (*Nasturtium officinale*) occurs in lush growths. At the type locality the spring emanates from a cave about 100 m north of Tennessee Highway 55 on the Joseph R. Banks property, Summitville, Coffee County. Until recently, the spring run was about 2-3 m wide and 10-30 cm deep, with moderate current. Chert-gravel substrate predominates in the current-swept areas, while the depositional areas associated with the watercress mat and the few unvegetated pools contain mud and silt substrates. Barrens topminnows typically occur in the calm-water habitats. Within the past

TABLE 2.—Distribution of Diploid Chromosome Counts Obtained for *Fundulus julisia*, Barrens Topminnow. Provided by W. M. Howell and Ann Black, Samford University.

Sex	Number of Specimens Analyzed	Number of Cells Analyzed	Diploid Counts					Modal Chromosome Number
			44	45	46	47	48	
♂	1	11	1*	1	----	----	9	48
♀	3	22	1	----	1	2	18	48

* Chromosome counts such as this probably result from loss of chromosomes due to disruption of cell membrane during spreading of chromosomes.

few years, Mr. Banks placed a low dam across the spring run just above Highway 55 in an attempt to provide a pool area for rainbow trout. Although the trout rapidly disappeared downstream, the pool, fortunately, provides a favorable habitat for the topminnows. One is often able to see several schools of them, about 10-20 per school, while standing on the edge of this ¼-acre pond. The spring run extends only about 400 m before entering West Fork Hickory Creek, which is currently receiving the effluent from a trailer court. Barrens top minnows have been occasionally taken in West Fork Hickory Creek near the mouth of the spring run. Noteworthy associated species at both the type locality and the Little Duck River include *Hemitremia flammea*, *Chologaster agassizi*, and *Etheostoma luteovinctum*. A male of the phryganeid caddisfly *Oligostomis ocelligera* (Walker), otherwise known only from as far south as Massachusetts and Michigan, was reported from the spring run by Etnier (1973).

Biology.—Spawning apparently takes place in early spring, based on presence of tuberculate males in available collections. W. M. Howell and S. K. Osborn, Samford University, have successfully reared this species in aquaria. They found (pers. comm.) that sexual activity could easily be initiated at other times of the year by providing the appropriate photoperiod. In aquaria adult males were extremely aggressive, often killing conspecific males and females, *and* on one occasion quickly killing a *Fundulus olivaceus* of comparable size.

Aquaria were maintained at room temperature, and food provided included frozen brine shrimp and Tetramin. Spawning occurred at water temperatures of 20-22° C. Spawning activity was apparently initiated by the male's chasing the female until she retreated into the spawning cover provided. Actual spawning was not observed because of the density of the cover, which consisted of floating mats of vegetation from the type locality, and a nylon mop suspended from a float on the surface of the aquarium. Fe-

Fig. 3.—Mitotic karyotype of a female Barrens topminnow, *Fundulus julisia*. This cell was derived from scale epithelium and shows a 2n = 48. The karyotype contains 46 acrocentric chromosomes of graded sizes and 2 small submetacentrics. Scale bar = 5 microns.

cundity is unknown, but a single spawning pair produced about 25 eggs daily which were later found adhering to the spawning substrate.

Status.—Fundulus julisia at present appears to be virtually restricted to the spring-run habitat at the type locality. This population, based on visual observation of the easily seen topminnows, probably does not exceed 200-500 individuals. In spite of repeated efforts, the species has not been collected in the Little Duck River locality since 1964, and has apparently disappeared from both Doak Springs and the Lake Ovaca locality, where only the 1938 collections are known. Dr. J. S. Ramsey, Auburn University (in litt.), surveyed about 40 small stream localities in Coffee County in 1975, but failed to locate additional populations. At present, this species must be considered as one of the most critically Endangered fishes in eastern North America. We applaud the recent efforts of Tennessee Wildlife Resources Agency, the Nature Conservancy, and Mr. Joseph R. Banks, who, on August 13, 1980, joined in a cooperative agreement designed to maintain the population of Barrens topminnows at the type locality, and to monitor this habitat carefully in order to detect any changes that might be detrimental to this population (Rogers, 1980). One of us (DAE) has received support from the U.S. Fish and Wildlife Service, Office of Endangered Species, to continue to search for additional populations of this species.

Subsequent to the preparation of this manuscript an additional population was found in the West Fork Hickory Creek System (Caney Fork drainage) in Coffee County, Tennessee. The population was discovered in October of 1981 in Meadow Creek about 150 yards above the L&N Railroad bridge, north of Tennessee Highway 55. This locality is approximately 2.6 air miles north-northeast of the type locality.

Etymology.—The species epithet, *julisia*, is derived from the Cherokee "amjulisi" = watercress, and "atsat" = fish (King, 1975). The common name, Barrens topminnow, was suggested by J. S. Ramsey, and refers to the Barrens Plateau area of the Highland Rim physiographic province to which the species is apparently restricted.

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